

THE ANNALS

AND

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[EIGHTH SERIES.]

“..... per litora spargite muscum,
Naiades, et circum vitreos considite fontes:
Pollice virgineo teneros hic carpite flores:
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Craterides, ite sub undas;
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchyliis succo.”
N. Parthenii Giannettasi, Ecl. 1.

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I.—*On some Jurassic Mollusca from Arabia.* By R.
BULLEN NEWTON, F.G.S., and G. C. CRICK, Assoc.R.S.M.,
F.G.S.

[Plates I.-III.]

PRELIMINARY STATEMENT.

THE fossils described in this communication, and which have been presented to the British Museum, were collected by Major H. S. Hazelgrove, of the Indian Army, from localities situated in South-western Arabia—Nobat Dakim and Dihala districts, the former about 50 miles north of Aden and the latter about double that distance also north of Aden. According to the letter and sketch-map accompanying the specimens, those from “Nobat” were obtained about 7 miles from that place in a basaltic region and are in a very dark grey limestone; the “Dihala” fossils, found in a light fawn-coloured rock, were discovered about 15 miles to the north-east of that locality, “at the tops of the small cultivated valleys which run up between the low spurs on which the

villages of Al-Kura and Samma stand," and apparently beneath the "Deccan Trap" series, which rise to a height of about 3500 feet.

PELECYPODA AND GASTROPODA.

By R. BULLEN NEWTON.

Among the specimens from Dihala are examples of *Parallelodon egertonianus*, a species of the Arciform-Pelecypods, which has been recorded from the Himalayas (Niti and Spiti) and also from Somaliland, and *Nucula cuneiformis*, previously found at both Spiti and Cutch, a closely related form to the European *N. cacilia*, Orbigny (= *N. ornati* of Quenstedt), of Callovian and Oxford Clay horizons.

Only one of the "Nobat" fossils is capable of determination. I refer to the natural limestone cast of a *Nerinea*, which shows strong affinities to *N. desvoidyi* of Orbigny, belonging to the European Corallian (Sequanian) Series.

These specimens are of interest not only from the fact that they enable us to announce for the first time the presence of a Jurassic fauna in Arabia, but also because they present a facies which connects them with the Bihin Limestone fauna of Somaliland and that of the Spiti Shales of Northern India, although, before pronouncing upon their probable geological age, it will be necessary to briefly consider what is known concerning the horizon of those two remote deposits.

The Bihin Limestone.—From a palæontological point of view the first notice of the Bihin Limestone of Somaliland is to be found in "A Note on the Geology of Somaliland," published in the 'Geological Magazine' for 1896, p. 290, by Dr. J. W. Gregory*, who gives a list of fossils found at Bihin, 15 miles from Berbera, which were determined by Messrs. G. C. Crick, F. A. Bather, and myself, including *Belemnites subhastatus*, Zieten, *Parallelodon egertonianus*, Stoliczka, *Rhynchonella edwardsi*, Chapuis & Dewalque, and *Rhynchonella subtetrahedra* of Davidson, the presence of which appeared to be of such value that the age of this limestone was regarded as Bathonian.

In further papers of the same journal, and immediately following Dr. Gregory's account, Mr. Crick and myself gave detailed notices of the fossils submitted to us, the *Parallelodon egertonianus* being referred to (pp. 294-296) as originally occurring in Northern Indian in company with several well-known European Jurassic Mollusca determined by Stoliczka

* References to the literature, when not included in the text, will be found further on in the paper under "Bibliography."

and regarded by that author as belonging to Quenstedt's "Brown Jura" or the "Dogger," evidence which was considered at the time in favour of the Bihin Limestone being recognized as of Bathonian age. Mr. Crick's remarks, however (pp. 296-298), on *Belemnites subhastatus* favoured the Callovian age for this limestone, since that Cephalopod was said to be characteristic of the *macrocephalus*-zone of Germany.

At a later period, during the discussion on a paper by Dr. Gregory "On the Geology and Fossil Corals and Echinids of Somaliland," read before the Geological Society, Mr. G. C. Crick stated that the Cephalopoda from the Bihin Limestone "appeared to indicate the presence of an horizon somewhat younger than Bathonian" (Quart. Journ. Geol. Soc. 1900, vol. lvi. p. 45).

Since the Bihin Limestone fossils were described, further specimens in the British Museum have been examined from the same beds, although no published account of them has yet been issued. Among these the following provisional determinations are now made:—*Nerinea* cf. *elatior*, Orbigny, a Corallian species represented by some narrow elongate natural casts; *Volsella* (= *Modiola*) *subangustissima*, Daqué, a form found in the Kimeridgian of Western Somaliland (Atschabo); *Pholadomya* cf. *carinata*, Goldfuss, originally described from the Callovian of the Sarthe region of France, and which has in more modern years been recognized by Douvillé as part of the Jurassic (Sequanian) fauna of Choa to the south of Abyssinia; *Ceromya* cf. *striata*, Orbigny sp. (= *obovata*, Römer, and *inflata*, Agassiz), belonging to Corallian and Kimeridgian times, a species recorded by G. Müller as occurring in the Kimeridgian of German East Africa; and *Terebratula subsella*, Leymerie, ranging from Corallian to Kimeridgian, although perhaps more characteristic of the former period, is known from the Kimeridgian of German Somaliland through the researches of Dr. Daqué, and according to Prof. Douvillé it also occurs in the Jurassic rocks of Choa to the south of Abyssinia.

The Spiti Shales.—The palæontology of the Spiti deposits of the Northern Himalaya appears to have been first made known to us by Captain J. D. Herbert in 1831, who gave an account, with a plate of figures, of a number of fossils that had been collected in those beds by Dr. Gerard. This was followed in 1833 by a further notice of the same collection written by the Rev. R. Everest, accompanied by two plates of fossils.

Thirty years afterwards the Gerard collection was again

studied, and this time by the late Dr. H. F. Blanford, who recognized in part an Upper Oolitic character of the species, which he considered were identical with, or closely allied to, forms characteristic of the Oxford Clay.

Dr. Oppel was the next student of this fauna, especially in connection with the Cephalopoda. He noted *Ammonites macrocephalus* as one of the characteristic species, and he therefore regarded the beds as of Callovian age and equivalent to the Kelloways-rock series of Europe.

Then followed Dr. Stoliczka's memoir*, dealing in part with the same subject, in which is enumerated the characteristic fossils of the Spiti Shales, with some remarks as to their horizontal value, as follows:—"The characteristic fossils are *Ammonites macrocephalus*, *parkinsoni*, *curvicosta*, *liparus*, *triplicatus*, and *biplex*; *Astarte major* and *unilateralis*, *Nucula cuneiformis*, *Trigonia costata*, &c.

"Without entering at present on the questions of separate zones, I believe the best equivalent of these beds is Quenstedt's *Brown Jura*, or now usually called *Dogger*, comprising a great number of so-called formations, clays, limestones, sandstones, shales, &c., which have in England, France, Germany, &c. only local value. The Himalayan Jura approaches in many respects in the character of its fossils to the Russian. It is a mistaken opinion to regard certain beds which contain *Planulati-Ammonites* as Upper Jura. The Spiti Shales have been treated in this manner because they abound in '*Planulati*.' But all those we do find, *Ammonites curvicosta*, *braikenridgii*, *triplicatus*, and the Kimeridgian form of *Am. biplex*, all these species are not Upper but Middle Jurassic; even if we could abstract all the rest of the fossils. *Trigonia costata* proves nothing, as it goes through many strata without essential alteration; similarly the *Avicula inæquivalvis*. The Cutch Deposits are equally not of Upper but of Middle Jurassic age, and have a great number of species identical with the *Oolite inférieur* of Bayeux and Montreuil Bellay."

These early determinations of the Spiti fossils have been subjected to considerable revision in recent years, and especially so in connection with the Cephalopoda, which have been more closely studied than the other groups of Mollusca.

The latest published views as to the age of the Spiti Shales appear in a monograph by Dr. Carl Diener on the geology of the Central Himalayan region, where the lower beds containing *Belemnites gerardi* are regarded as Upper Jurassic and

* Stoliczka, Mem. Geol. Surv. India, 1865, vol. v. part 1, p. 139.

included in his division of the "Chidamu Beds." The same author states that Professor Victor Uhlig agrees with this correlation, besides thinking it probable that the Chidamu Beds are Kimeridgian*.

It should also be mentioned here that Professor Uhlig is now engaged in examining and reporting upon "The Fauna of the Spiti Shales," descriptions of the Ammonite species having already been published; and we await with interest the completion of that work, which should finally settle all disputes as to the stratigraphical values of those northern Indian deposits.

Age of the Arabian Mollusca.—In considering the geological age of Major Hazelgrove's fossils from Arabia it would seem that there is every evidence to prove that they belong to a higher horizon than the Bathonian. The *Parallelodon egertonianus*, as previously mentioned, shows some similarity with a Kimeridgian form from German East Africa. Then, again, the *Nucula cuneiformis*, which is characteristic of Indian Jurassic deposits, exhibits besides some marked affinities with Quenstedt's *N. ornati*, occurring in the Oxfordian of Germany and England. The *Nerinea*-cast also appears to possess certain characters which would connect it with the Corallian period. From such comparisons it is reasonable to assume that this fauna should be recognized as originating somewhere between the Oxfordian and Kimeridgian, in which case the Corallian (or Sequanian) would represent its rightful period in the Jurassic series.

Every detail of research made in connection with the present enquiry tends to indicate that these Arabian limestones may be correlated with the Jurassic rocks of Bihin and probably other districts of Eastern Africa, as well as with those occurring on the Tibetan side of the Himalayas—the Niti Pass neighbourhood north of Kumaun and the Spiti district N.N.E. of Simla—and with certain rocks in the Cutch province of Western India. Similar Jurassic regions are also known in Persia, Baluchistan, and Madagascar.

DESCRIPTION OF THE SPECIES.

PELECYPODA.

Genus PARALLELODON, Meek and Worthen.

Parallelodon egertonianus, Stoliczka. (Pl. I. figs. 1-4.)

Arca, J. D. Herbert, Gleanings in Science, 1831, vol. iii. pl. xvii. fig. 6, p. 272.

* These opinions are reproduced and adopted in Professor A. de Lapparent's 'Traité de Géologie,' 1906, edition 5, p. 1255.

- Arca*, Everest, Asiatic Researches, 1833, vol. xviii. pt. 2, pl. ii. fig. 27, p. 114.
Cucullæa virgata, Blanford, Journ. Asiatic Soc. Bengal, 1863, p. 136 ; Blanford and Salter, Palæontology of Niti, Northern Himalaya, 1865, p. 103 ; non J. de C. Sowerby, 1840.
Macrodon egertonianum, Stoliczka, Mem. Geol. Surv. India, 1865, vol. v. pl. viii. fig. 7, p. 89.
Parallelodon egertonianus, R. B. Newton, Geological Magazine, 1896, pp. 294-296.

From Stoliczka's diagnosis we understand this species to be an obliquely elongate shell, convex, narrow, and with radiating costæ ; the costæ are fewer and consequently wider apart towards the anterior margin and nearly obsolete posteriorly ; concentric striæ unequal, undulating, sometimes lamellose. These characters are mostly well expressed in the valves from Arabia now referred to this species, although the posterior radiating costæ are more apparent than in Indian examples, a fact which is probably due to better preservation.

Rather more than eleven years ago I recognized this species among the Bihin Limestone fossils of Somaliland, and I then referred to a peculiarity of ornamentation seen only on the right valve, which had not previously been noticed, viz. the presence of intermittent ribbing between the primary radial costæ, a structure which I also observed at the same time in some of the original Indian specimens in the British Museum collected by the late Sir Richard Strachey, and which is further observable in the valves from Arabia. I now find the same sculpture in J. de C. Sowerby's *Cucullæa virgata* from the Cutch Jurassic, a species which has already been mistaken for *egertonianus*, although it represents a shell of very different contour, being more or less quadrate and, moreover, furnished with almost central umbones, and altogether lacking the obliquity of the Spiti form.

Very similar sculpture is present on the left valve of *Cucullæa lasti*, described by G. Müller (in Bornhardt, 'Deutsch. Ost-Afrika,' 1900, vol. vii. pl. xvii. figs. 1, 2, p. 533) from the Kimeridgian of German East Africa ; but that form has also more central umbones, less oblique radial costæ, and rather more inflated valves.

This *egertonianus* is also quite distinct from Dr. Dacqué's *Macrodon rufæ* * from the Kimeridgian of Western Somaliland (Atschabo and Harro Rufa), as pointed out by that author, who further regards his species as showing a greater

* "Beiträge zur Geologie des Somalilandes," Beitr. Paläontologie Geologie Oesterr.-Ungarns Orients, 1905, vol. xvii. pl. xv. figs. 4-6, pp. 137, 138.

resemblance to *Arca* (*Cucullæa*?) *jonesi* of Tate * from the Uitenhage beds of South Africa.

Like the Indian and African specimens, the Arabian examples are sometimes a good deal crushed, although two of the largest left valves exhibit their natural convexity. The valves also vary in size, the largest having a height of 30 mm. and a length of 54 mm.

The ligament area in most examples is not preserved, but a sectioned left valve shows a fairly deep concavity beneath the umbo, but unfortunately without surface structure; this same specimen exhibits evidence of the elongate horizontal teeth at the posterior end of hinge-line, which serve to indicate the generic position of this species.

Loc. Near Dihala.

Genus NUCULA, Lamarck.

Nucula cuneiformis, J. de C. Sowerby.

(Pl. I. figs. 5-7.)

Modiola, J. D. Herbert, Gleanings in Science, 1831, vol. iii. pl. xvii. fig. 5, p. 272; Everest, Asiatic Researches, 1833, vol. xviii. pt. 2, fig. 28, p. 114.

Nucula, J. de C. Sowerby, Asiatic Researches, 1833, vol. xviii. pt. 2, p. 278.

Nucula? *cuneiformis*, J. de C. Sowerby, Trans. Geol. Soc. London, 1840, ser. 2, vol. v. pl. xxii. fig. 4, p. 328.

Nucula cuneiformis, H. F. Blanford, Journ. Asiatic Soc. Bengal, 1863, vol. xxxii. p. 135.

Nucula cuneiformis, Stoliczka, Mem. Geol. Surv. India, 1865, vol. v. p. 90.

Among the Arabian specimens are some inflated examples of a *Nucula* which show so great a resemblance to *N. cuneiformis* from the Jurassic rocks of Spiti and Cutch that I am unable to separate them from that species.

In Sowerby's original description of the shell it is stated to be "transversely elongate-elliptical, gibbose, smooth; beaks † close to the anterior extremity, small, incurved."

Unfortunately the type of the species is missing from Capt. C. W. Grant's collection of Cutch fossils in the Geological Society's Museum, although I am enabled to institute a comparison, as there happens to be an example of this shell (determined by myself) in the Rev. J. F. Blake's collection

* Quart. Journ. Geol. Soc. 1867, vol. xxiii. pl. ix. fig. 9, p. 161.

† It may be here mentioned that *Nucula* is one of the few genera which has posteriorly directed umbones (opisthogyrous); therefore the position of the "beaks" should be referred to as posterior, and not anterior.

of fossils from that area of India, now in the British Museum. The late Dr. H. F. Blanford recognized some distorted specimens from the Himalayan Jurassics, previously figured by Herbert and Everest as *Modiola* and by J. de C. Sowerby as *Nucula*, as forms of the *N. ? cuneiformis*, an opinion which was subsequently confirmed by Stoliczka in his memoir dealing with the Spiti Shales of the North-western Himalaya.

The Arabian shells show distortion through pressure as characterize most of the Spiti examples; their valves are of similar size and ornamentation, just as inflated, possessing incurved posterior umbones, the surface of posterior end being abruptly truncated and mostly occupied by a wide lunule. The characteristic dentition of the genus has been displayed by the rubbing down of the dorsal surface of one of the specimens.

The Cutch specimen used for comparison exhibits rather more roundness of contour, although the slightly angulate appearance of the Arabian valves is probably more or less due to the pressure to which they have been partially subjected during the period of fossilization.

Accompanying the specimens of *Nucula cuneiformis* are some very depressed valves which have probably undergone lateral pressure, making it possible that they belong to the same species; a rubbed down surface of one of these valves exhibits the characteristic nuculoid dentition.

Among European shells this species is closely related to *Nucula ornati* of Quenstedt ('Handbuch Petrefactenkunde,' 1852, pl. xlv. fig. 7, p. 528) from Kelloways Rock and Oxford Clay horizons, a form subsequently recognized by Albert Oppel as *Nucula cecilia* of Orbigny ('Prodrome Pal. Strat.' 1849, vol. i. p. 339; 'Die Juraformation,' 1857, p. 565) of Callovian age. The same form has also been figured under the name of *N. ornata*, Quenstedt, from the Oxford Clay of Weymouth, in Robert Damon's 'Geology of Weymouth,' 1888, pl. ii. figs. 6-8), the types of which are in the British Museum.

Loc. Near Dihala.

GASTROPODA.

Genus TROCHUS, Linnæus.

Trochus arabiensis, sp. n. (Pl. I. figs. 8, 9.)

Description.—Shell conical, smooth, and with subobtusely apex; with five depressed, narrowly sutured, slightly turreted whorls on nearly the same plane, which are more or less

concave on the upper surface, the last having a sharply carinated periphery; base inflated and doubtfully umbilicate; aperture apparently subcircular; sculpture comprising fine, closely arranged, regular spiral striations both on the upper and basal surfaces, crossed by oblique lines of growth which are strongest and most evident at the base; lower margin of whorls obscurely tubercled.

Dimensions.—Height=22, diameter=18 mm.

The two specimens now described somewhat resemble the genus *Amberleya*, though not so prominently turreted as most known forms of that genus, and of much less decorative sculpture than usually obtains. I know of no form of Jurassic Trochidæ similarly ornamented. About twelve of the regular spiral lines can be counted on the surface of the penultimate and body-whorl (where they are best seen), and there are slight indications of tubercles on the periphery, although the specimens are somewhat worn and coated in places with the light-coloured matrix.

The base is fairly ventricose, but whether there is an umbilication or not is very uncertain, as the hard limestone covers up this part of the basal region.

The form is of interest to record as it accompanies the shells found in the light-coloured limestone, and unquestionably forms part of the same fauna, although its relationship to other species has not been traced. There is, however, a slight similarity of structure to a form figured by Dr. Dacqué (*Trochus* sp. indet.) from the Kimeridgian of Somaliland (Atschabo), but without specimens for actual examination a more accurate comparison is not possible (pl. xvi. fig. 8, p. 142 of Dacqué's memoir, quoted in the list of literature), although a peripheral keel is present on the lower whorl.

Loc. Near Dihala.

Genus NERINÆA, DeFrance.

Nerinæa cf. *desvoidyi*, Orbigny. (Pl. I. fig. 10.)

Nerinæa desvoidyi, Orbigny, Prodrôme Paléontologie Stratigraphique, 1850, vol. ii. p. 4; Pal. Française, Terr. Jurassiques, Gastéropodes, 1850, pl. cclxi. p. 107.

Nerinæa gosaë, Contejean, Kimméridien de Montbéliard, 1859, pl. vii. fig. 1, p. 231; (pars) Thurman and Etallon, Lethæa Bruntrutana, 1864, pl. vii. fig. 38, p. 93, non Römer.

Nerinæa desvoidyi, P. de Loriol, Mon. Paléont. Géol. Étages Sup. Jurassique, Mém. Soc. Linn. Normandie, 1872, vol. xv. pl. vi. figs. 2-5, p. 81; Blake and Hudleston, Quart. Journ. Geol. Soc. 1877, vol. xxxiii. p. 266.

This specimen is a natural cast of a large fragment of

Nerinea, and regarded as having close affinities with *N. desvoidyi* from the Corallian (Sequanian) rocks of France. It measures 125 mm. in length and consists of rather more than six whorls of greater width than height, each one showing an oblique central depression which is parallel with a well-marked suture. The general form is narrow and elongate, the whorls very gradually enlarging with age, and appearing to exactly correspond with P. de Loriol's figures of a cast from Normandy (pl. vi. figs. 3, 4) which exhibits a similar rate of increase in the volutions and the same obliquity at the median depression. A small patch of original shell-structure is still to be seen on the basal whorl, although not included in our illustration, showing some obscure lines of growth, which, however, are less sinuous than those depicted by Orbigny in his original figure.

The present specimen shows also considerable resemblance to Römer's *N. gosæ*, as interpreted by Goldfuss ('Petrefacta Germaniæ,' 1844, vol. iii. pl. clxxv. fig. 9, p. 41), from the German Portlandian; but the whorls appear to be higher and the suture more oblique.

A very similar cast of this genus has been figured and described by Coquand under the name of *N. pauli* from the Lower Cretaceous (Barremian) deposits of the Province of Constantine in Northern Africa ('Géologie et Paléontologie Constantine,' 1862, pl. iv. fig. 3), but it is capable of separation from the present form by its taller volutions and their more deeply excavated sides.

Messrs. J. F. Blake and W. H. Hudleston acknowledge this species in the Corallian strata of Weymouth.

The blackish limestone containing this specimen has also produced a few casts of naticoid and bivalve shells; but these are of no scientific importance, as their determination is quite impossible.

Loc. Near Nobat.

CEPHALOPODA.

By G. C. CRICK.

As has already been explained, Major Hazelgrove's collection was obtained at two localities in S.W. Arabia—(1) in the neighbourhood of Nobat Dakim, about 50 miles north of Aden, and (2) from the neighbourhood of the villages of Al-Kura and Samma, to the N.E. of Dihala, about 100 miles N. of Aden. In a letter accompanying the specimens Major Hazelgrove writes:—"I have marked the seven dark specimens 'Nobat,' though I found them about seven miles from

that place, at the end of a long valley which runs north from Nobat Dakim. All the remaining fossils were found at the tops of the small cultivated valleys which run up between the low spurs on which the villages of Al-Kura and Samma stand; and there were several more neighbouring valleys of the same sort, with fossils in them in similar situations."

According to the sketch-map accompanying the specimens, the fossils marked "Nobat" were found between layers of basalt on the western side of Jebel Manif (2500 feet), about 7 miles N.N.E. from Nobat Dakim. The villages of Al-Kura and Samma, near which the remaining fossils were found beneath Deccan trap, are at a distance of about 15 miles N.E. of Dihala.

Only one Cephalopod (the Belemnite) is labelled "Nobat." It is, however, to be observed that the small portions of matrix still adhering to this specimen agree perfectly with the matrix of the fossils from near Dihala, whilst its state of preservation differs entirely from that of the other specimens labelled "Nobat."

The Cephalopoda comprise two Nautili, five Ammonites, and one Belemnite. A perfectly flat and smooth internal cast, about 40 mm. in diameter, without any indication whatever of sutures, is possibly the remains of an Ammonite. The Nautili and Ammonites are contained in a light fawn-coloured limestone; they are all very much crushed, and in no single instance is it possible to make out a suture-line. Portions of matrix on the Belemnite indicate that that also was obtained from similar rocks.

DESCRIPTION OF THE SPECIES.

A. NAUTILOIDEA.

Genus NAUTILUS, Breyn.

Nautilus cf. *hexagonus*, J. de C. Sowerby.
(Pl. II. fig. 2.)

1826. *Nautilus hexagonus*, J. de C. Sowerby, Min. Conch. vol. vi. p. 55, pl. dxxix. fig. 2. (For references, see A. H. Foord, Cat. Foss. Ceph. Brit. Mus. pt. 2, 1891, pp. 235-236.)

Using the name in a broad sense, the genus *Nautilus* is represented by two examples, about 90 and 95 mm. in diameter respectively. Both are doubtless referable to the same species, but are so very much crushed that their original dimensions cannot now be ascertained. The shell appears to have been rather inflated and rapidly expanding, and

to have had its greatest thickness at the margin of the umbilicus. This seems to have been relatively small and may possibly have been closed, but unfortunately it is obscured in both specimens. The sides are flattened and convergent and their outer half is slightly concave; the periphery is flattened, is about one-half the width of the sides, where the shell has a diameter of about 90 mm., and has subangular margins, and in one specimen there is a shallow longitudinal groove almost close to the margin. The whole surface is ornamented with rather coarse lines of growth, which in crossing the whorl pass from the umbilical margin across the lateral area in a slightly backward direction, and with a feeble orad-concave curve at about the middle of this area as far as the subangular peripheral margin, where they turn rather abruptly backward, so as to form a relatively deep hyponomic sinus on the periphery. The position of the siphuncle is not seen, and the septa are not shown.

In its crushed condition, showing only the ornaments of the test, and neither the position of the siphuncle nor the form of the suture, its identification is rendered extremely difficult.

The Arabian fossil bears much resemblance to *Nautilus hexagonus*, described by J. de C. Sowerby* from the Calcareous grit of Shotover, Oxfordshire, and of Abingdon, Berkshire †, &c., the ornaments of the test corresponding exactly with those shown in Sowerby's figure; but the Arabian species appears to have had relatively a narrower periphery. The specimen from near Charee, in Cutch, that J. de C. Sowerby ‡ referred with a query to that species because it differed "in having a smaller umbilicus and in being more rounded," is referred to *Nautilus calloviensis*, Oppel §, by Waagen ||, who states that in Cutch it is found in beds associated with *Macrocephalites macrocephalus*. From the Upper Jurassic rocks of Mombasa in East Africa Beyrich ¶ records a fragmentary specimen as being allied to *Nautilus hexagonus*.

* J. de C. Sowerby, Min. Conch. vol. vi. p. 55 (1826), pl. dxxix. fig. 2.

† The species has also been recorded in rocks ranging from the Stonesfield Slate (Great Oolite, Bathonian) up to the Kimeridge Clay (see A. H. Foord, Cat. Foss. Ceph. Brit. Mus. pt. 2, 1891, pp. 235-236), but it is very doubtful if all these records refer to Sowerby's species.

‡ J. de C. Sowerby, Trans. Geol. Soc. [2] vol. v. pt. 2, 1840, p. 329, pl. xxiii. fig. 4, expl. of plate (unpaged). This specimen is now in the Museum of the Geological Society of London.

§ A. Oppel, 'Die Juraformation,' 1856-8, p. 547 (1857).

|| W. Waagen, 'Jurassic Fauna of Kutch' (Pal. Indica), vol. i. Cephalopoda, pt. 1, 1873, p. 18, pl. iii. figs. 2 a, b.

¶ H. E. Beyrich, "Ueber Hildebrandt's geologische Sammlungen von Mombassa," Monatsber. d. k. Preussischen Akad. d. Wissenschaften za Berlin, 1878, pp. 767-775.

In its general form the Arabian species possibly closely resembled the form which Dacqué * has described (as *Nautilus ennianus*) from Somaliland from beds which he regards as of Kimeridgian age. The Somaliland fossil has a similar subangular-margined periphery, but its ornaments are unknown.

The concave peripheral area of *Nautilus giganteus*—a species sometimes regarded † as a synonym of J. de C. Sowerby's *Nautilus hexagonus*—described by d'Orbigny ‡ from the Lower Oxfordian, but recorded § also from beds of Lower Kimeridgian age, seems to distinguish that species from both the Arabian and Somaliland forms.

Of the species recorded from the Jurassic rocks of Cutch, the Arabian form may be compared with both *Nautilus kumagunensis*, Waagen ||, and *Nautilus wandaensis*, Waagen ¶; from the former, however, it seems to be distinguished by its coarser lines of growth and apparently more robust form, and from the latter by its probably narrower and more sharply defined periphery. On the whole, however, it seems to come nearer the latter, but unfortunately in that species the test, which is very well shown in the present specimens, is incompletely known. *Nautilus kumagunensis* occurs in the upper region of the *macrocephalus*-beds, whilst *N. wandaensis* occurs in the Dhosa Oolite in association with *Aspidoceras perarmatum*. *Nautilus wandaensis* has also been recorded, in association with *Perisphinctes*, *Macrocephalites*, indeterminate fragments of *Belemnites*, and a new species of *Rhynchonella*, from Mtaru in German East Africa, from rocks regarded as of the same age as the Dhosa Oolite ** of Cutch.

The flat, sharply-defined periphery, with its subangular margins and feeble longitudinal sulcus near the margin, the slight depression of the outer part of the lateral area, and the direction of the lines of growth in the Arabian example

* E. Dacqué, Beitr. zur Paläont. u. Geol. Oesterr.-Ungarns, &c., Bd. xvii. Heft 3 & 4, p. 144, pl. xvii. fig. 5.

† See A. H. Foord, Cat. Foss. Ceph. Brit. Mus. pt. 2, 1891, pp. 235-236.

‡ A. D. d'Orbigny, Pal. Franç., Terr. jurass. vol. i. 1842, p. 163, pl. xxxvi.

§ A. Etallon, "Lethæa Bruntrutana, &c.," pt. 1 (Neue Denkschriften der allgemeinen Schweizerischen Gesellschaft für die gesammten Naturwissenschaften, Bd. xviii.), 1861, p. 74, pl. i. fig. 2.

|| W. Waagen, 'Jurassic Fauna of Kutch' (Pal. Indica), vol. i. Cephalopoda, pt. 1, 1873, p. 19, pl. iii. figs. 1 a, b.

¶ W. Waagen, *op. cit.* pt. 1, 1873, p. 17, pl. iv. figs. 3 a, b.

** A. Tornquist, "Fragmente einer Oxfordfauna von Mtaru im Deutsch-Ostafrika, nach dem von Dr. Stuhlmann gesammelten Material," Jahrb. Hamburgischen Wissensch. Anstalten, Jahrg. x. (1892), p. 281.

suggest a comparison with Retowski's genus *Tithonoceras**, which was founded upon a new species *T. zitteli* † from the Tithonian of the Crimea, but the depression of the outer portion of the lateral area and the longitudinal sulcus on the periphery near its margin are not nearly so distinct as in that genus, and there is an absence of any depression along the median line of the periphery—in fact, in the Arabian specimens the periphery is feebly convex, whilst in the genus *Tithonoceras* it is rather concave.

The Arabian species appears to be intermediate between such a form as *Nautilus hexagonus* and the genus *Tithonoceras*, and probably finds a near ally in Dacqué's *Nautilus ennianus* from the Kimeridgian rocks of Atschabo in Somaliland.

Loc. Valleys between the villages of Al-Kura and Samma, about 15 miles N.E. of Dihala.

B. AMMONOIDEA.

Genus PERISPHINCTES, Waagen.

With one possible exception, the Ammonites in the collection are referable to the genus *Perisphinctes*. All are more or less imperfectly preserved, but, though very much crushed, portions of the test are usually present. In no case, however, is it possible to see the suture-line. The condition of the specimens, therefore, renders the identification of the species particularly difficult.

Perisphinctes cf. *torquatus* (J. de C. Sowerby). (Pl. III. figs. 1 a, b.)

1840. *Ammonites torquatus*, J. de C. Sowerby, Trans. Geol. Soc. [2] vol. v. pt. 2, p. 719, pl. lxi. fig. 12 & expl.
 1863. ? *Ammonites torquatus*, J. de C. Sowerby; H. F. Blanford, Journ. Asiatic Soc. Bengal, vol. xxxii. no. 2, p. 130, pl. iii. figs. 6, 6 a, 7, 7 a, 8.
 ? 1865. *Ammonites torquatus*, J. de C. Sowerby; H. F. Blanford, in J. W. Salter and H. F. Blanford, Palæont. Niti, p. 80.
 1875. *Perisphinctes torquatus* (J. de C. Sowerby); W. Waagen, Jurassic Fauna of Kutch (Pal. Indica), vol. i. Cephalopoda, pt. 4, p. 191, pl. liv.
 1898. *Perisphinctes torquatus* (J. de C. Sowerby); J. v. Siemiradzki, Palæontographica, Bd. xlv. p. 263.

The best-preserved Ammonite in the collection was partially exposed on the surface of a small slab of limestone.

* O. Retowski, "Die tithonischen Ablagerungen von Theodosia," Bull. Soc. Imp. Nat. Moscou, 1893, no. 2 & 3, p. 222.

† O. Retowski, *op. cit.* p. 223, p. xiii. figs. 2 a, b, c.

By careful development it has been possible to almost completely expose the lateral area and a portion of the periphery (Pl. III. figs. 1 *a*, *b*). In its crushed state the fossil has the following dimensions:—diameter of outer whorl 92 mm. (1) * ; height of outer whorl 30 (0·326) ; width of umbilicus about 39 (0·42) ; the thickness of the whorl being indeterminable. There are 42 or 43 principal ribs in the outer whorl ; each, after traversing the narrow umbilical wall of the whorl, passes forward in crossing the lateral area and bifurcates at about the middle of this area into two equally strong ribs, which cross the periphery without any interruption in an orad-convex curve. Occasionally, but very rarely, there is a principal rib which does not bifurcate. There is no trace of the suture-line.

The fossil is most probably referable to J. de C. Sowerby's *Ammonites torquatus*. The type-specimen, which came from the "Desert N.E. of Cutch" †, has the following measurements:—diameter of shell 64·5 mm. ‡ (1) ; height of outer whorl 21·5 (0·33) ; thickness of outer whorl 23 (0·35), and width of umbilicus 28 (0·43). The outer whorl bears 41 principal ribs. Thus it will be seen that both in measurements and ornaments the Arabian shell approaches very closely the Cutch form. In his work on the Jurassic Cephalopoda of Cutch, Waagen § figures only a large completely septate example, and states that all the specimens in the Museum of the Geological Survey of India came from "the coarse red iron-sandstone of the Katrol range, that is, from the middle region of the Katrol Group." It is stated to be one of the commonest Ammonites of the Katrol Group ¶. The ornaments of the Arabian fossil agree very closely with those of the larger of the two specimens (figs. 6, 6 *a*) from the Spiti Valley figured by H. F. Blanford ¶¶, and referred by him with a query to Sowerby's species. Unfortunately neither the suture-line nor the form of the transverse section is available for comparison in the Arabian fossil. The

* The numbers in parentheses accompanying the dimensions measured in millimetres indicate the proportion of each of them to the whole diameter taken as unity.

† *Op. cit.* p. 719. The specimen is now in the Museum of the Geological Society of London.

‡ The specimen is 68 mm. in diameter, but owing to the imperfection of its anterior end its dimensions can be best taken at a diameter of 64·5 mm.

§ W. Waagen, *op. cit.* pt. 2, 1875, p. 191, pl. liv.

¶ R. D. Oldham, *Manual Geol. India*, 1893, p. 222.

¶¶ H. F. Blanford, *Journ. Asiat. Soc. Bengal*, vol. xxxii. 1863, p. 130, pl. iii. figs. 6, 6 *a*, 7, 7 *a*, 8.

absence of these same characters prevents a full comparison with the Niti examples, which H. F. Blanford referred to *Ammonites torquatus** and *A. biplex*†, two forms very closely allied, if not identical, the only characters by which that author distinguished the two forms being the thicker and more depressed whorls of the former, accompanied by a slight notching of the ribs in the median line of the periphery. He did not figure *A. torquatus*, but figured two examples as *A. biplex*. Of these, the specimen depicted in pl. xi. fig. 1 a ‡ more closely resembles the Arabian form, especially in the coarseness and direction of its ornaments, but being a more widely umbilicated shell, its outer whorl bears a greater number (55) of principal ribs than that of the Arabian fossil.

Compared with Waagen's figure § of *Perisphinctes martelli*, Opper, from the Kuntkote Sandstone, the measurements of which agree fairly well with those of the Arabian specimen, the latter possessed coarser and more curved ornaments, and apparently had more inflated sides than the Indian form; further, the bifurcation of the ribs appears to have been nearer the margin of the periphery in the Indian than in the Arabian form.

Another Indian form with which the Arabian specimen may be compared is Waagen's *Perisphinctes virguloides*||, but compared with Waagen's figure (pl. xlix. figs. 1 a, 1 b) the Arabian fossil is more narrowly umbilicated and its ribs are less numerous per whorl and more forwardly-directed in crossing the lateral area. In Cutch, Waagen's species is restricted to the Kuntkote Sandstone. The Arabian fossil agrees still more closely with Pavlow's figure of a specimen, which he refers to Waagen's species, from the zone of *Aspidoceras acanthicum* from the East of Russia ¶.

It also closely resembles de Loriol's figure** of *Perisphinctes eupalus* (d'Orbigny) from the zone of *Oppelia tenuilobata* of Oberbuchsitten (Soleure); its relative dimensions are about

* H. F. Blanford, in J. W. Salter and H. F. Blanford, Palæont. Niti, 1865, p. 80.

† H. F. Blanford, *op. cit.* p. 79, pl. xi. figs. 1 a, b, c, pl. xii. figs. 1 a, b, c.

‡ Now in British Museum collection, register no. C. 5033.

§ W. Waagen, *op. cit.* pt. 4, 1875, pl. lv. figs. 3 a, b.

|| W. Waagen, *op. cit.* pt. 4, 1875, p. 203, pl. xlvii. figs. 4 a, b, pl. xlix. figs. 1 a, b.

¶ A. Pavlow, "Les Ammonites de la zone à *Aspidoceras acanthicum* de l'est de la Russie," *Mém. Com. Géol. St. Pétersbourg*, vol. ii. no. 3, 1886, pp. 28 & 85, pl. vii. figs. 3 a, b.

** P. de Loriol, "Monographie paléontologique des couches de la zone à *Ammonites tenuilobatus* (Badener Schichten) d'Oberbuchsitten et de Wengen (Soleure)," pt. i., 1881 (*Mém. Soc. Pal. Suisse*, vol. vii.), pl. iii. figs. 2, 2 a.

the same, so far as they can be compared with the Arabian specimen, although the measurements of the figure do not quite agree with the dimensions given by de Loriol (p. 16) *; but its ornaments appear to be somewhat finer and fewer, de Loriol's example having 47 principal ribs in the outer whorl, whereas the Arabian fossil has only 42 or 43.

This specimen, then, seems to find its nearest ally in *Perisphinctes torquatus*, which occurs in the Katrol Group in Cutch in beds which are referred to by Siemiradzki † as Lower Kimeridgian; at Niti and Spiti in the Himalaya; and, according to Siemiradzki, also in the zone of *Oppelia tenuilobata* in Poland, and probably also in Swabia.

A crushed specimen, about 34 mm. in diameter, exposed on the surface of a small piece of limestone, appears to be referable to this same species.

Loc. Valleys between the villages of Al-Kura and Samma, about 15 miles N.E. of Dihala.

Perisphinctes cf. *subdolos*, Fontannes.

(Pl. II. fig. 3.)

1879. *Perisphinctes subdolos*, F. Fontannes, Description des Ammonites des calcaires du Château de Crussol, Ardèche (Zones à *Oppelia tenuilobata* et *Waagenia beckeri*), p. 61, pl. ix. fig. 3.

1898. *Perisphinctes subdolos*, F. Fontannes; J. v. Siemiradzki, Palæontographica, Bd. xlv. Lief. 2 & 3, p. 153.

Another species of the genus *Perisphinctes*, represented by the crushed half of a specimen of about 83 mm. in diameter and with the inner whorls obscured by matrix, bears some resemblance in the character of its ribbing to *Perisphinctes subdolos*, Fontannes, a rather common species in the zone of *Oppelia tenuilobata* of Crussol (Ardèche); but it appears to have been a more widely umbilicated shell with relatively narrower (*i. e.* less high) whorls, for the diameter of its umbilicus at about its greatest diameter (=1) appears to be

* The measurements given by de Loriol are:—greatest diameter 78 mm.; width [height] of last whorl, in proportion to the diameter, 0·37; thickness of last whorl, in proportion to the diameter, 0·34; diameter [width] of umbilicus, in proportion to the diameter, 0·37. From these dimensions it would appear that the width [height] of the last whorl and the diameter of the umbilicus were equal, but such is not the case in de Loriol's figure. Our dimensions of the figure are:—greatest diameter 79·5 mm. (1); height of last whorl 27 (0·34); thickness of last whorl 28 (0·35); width of umbilicus 33·5 (0·42).

† J. v. Siemiradzki, 'Palæontographica,' Band xlv. Lief. 4 & 5, 1898, p. 264. A. de Lapparent divides the Katrol group into two parts, and regards the Lower part as of Sequanian age and the Upper as of Kimeridgian age ('Traité de Géologie,' 5th ed. 1906, vol. ii. pp. 1243 & 1255).

about 42 mm. (0·50) and the height of the outer whorl about 25 mm. (0·30), whereas these proportions in an example of Fontannes's species of 81 mm. in diameter are given as 0·45 and 0·31 respectively.

Loc. Valleys between the villages of Al-Kura and Samma, about 15 miles N.E. of Dihala.

Perisphinctes cf. *abadiensis*, Choffat.
(Pl. III. fig. 2.)

1893. *Perisphinctes abadiensis*, P. Choffat, Faune jurass. Portugal, Cephalopodes, 1^{ère} sér., Ammonites du Lusitanien &c. p. 46, pl. xviii. figs. 1, 2.

1898. *Perisphinctes abadiensis*, P. Choffat; J. v. Siemiradzki, Palæontographica, Bd. xlv. Lief. 4 & 5, p. 164.

The crushed remains of an example of about 100 mm. in diameter, exhibiting only a portion of the outer whorl, the inner whorls being obscured by matrix, seems to agree very well with Dacqué's figure * of a specimen, from rocks of Kimeridgian age in Somaliland, that he compares with Choffat's species from Portugal †. Siemiradzki ‡ records the species also from Poland.

It bears also considerable resemblance to de Loriol's figure § of *Perisphinctes polygyratus* (Reinecke) from the zone of *Oppelia tenuilobata* of Oberbuchsitten (Soleure).

Loc. Valleys between the villages of Al-Kura and Samma, about 15 miles N.E. of Dihala.

Perisphinctes cf. *pottingeri*, J. de C. Sowerby, sp.
(Pl. III. figs. 3 a, b.)

1840. *Ammonites pottingeri*, J. de C. Sowerby, Trans. Geol. Soc. [2] vol. v. p. 719, pl. lxi. fig. 10 & expl. of figure.

1875. *Perisphinctes pottingeri* (J. de C. Sowerby); W. Waagen, Jurassic Fauna of Kutch, vol. i. Cephalopoda, pt. 4, p. 183, pl. li. figs. 1 a, b.

1894. *Perisphinctes pottingeri* (J. de C. Sowerby); K. Fütterer, Zeitschr. Deutsch. geol. Gesell. Bd. xlvi. p. 7, pl. i. fig. 2.

1898. *Perisphinctes pottingeri* (J. de C. Sowerby); J. v. Siemiradzki, Palæontographica, Bd. xlv. Lief. 2 & 3, p. 157.

A fragment of a whorl about 32 mm. long exhibits rather

* E. Dacqué, Beitr. zur Paläont. u. Geol., Oesterr.-Ung. &c. Bd. xvii. Heft 3 & 4, 1905, p. 148, pl. xv. figs. 15 a, b.

† Paul Choffat, *loc. cit.*

‡ J. v. Siemiradzki, *loc. cit.*

§ P. de Loriol, "Monographie paléontologique des couches de la zone à *Ammonites tenuilobatus* (Badener Schichten) d'Oberbuchsitten et de Wengen (Soleure)," pt. i. 1881 (Mém. Soc. Pal. Suisse, vol. vii.), pl. vi. fig. 4.

coarse ribs, showing a definite bifurcation on the lateral area into two equally coarse ribs which pass without interruption over the peripheral area. Unfortunately the specimen is so imperfect that it does not exhibit the whole height of the whorl, and it is so crushed that it does not show the original shape of the transverse section of the whorl. The ornaments appear to be relatively coarser than those of the other examples of *Perisphinctes* in the collection; the character of the bifurcation of the ribs is also slightly different, there being in this fragment a slight thickening at the point of bifurcation. The ribbing, in fact, agrees very closely with that of the earliest portion of the outer whorl of Sowerby's type specimen of *Perisphinctes pottingeri*, with which we have compared it. Sowerby's type specimen came from the "Desert N.E. of Cutch." According to Waagen, this species and the closely allied but more coarsely ornamented form *Perisphinctes katrolensis* * are in Cutch very common in the coarse iron-sandstone of the Katrol range that corresponds to about the middle of the Katrol Group. Dr. Waagen regarded the Cephalopoda of this group as corresponding to those of the Kimeridgian and Upper Oxfordian beds of Europe. The group is divided into two parts, of which de Lapparent regards the Lower as of Sequanian and the Upper as of Kimeridgian age †.

Loc. Valleys between the villages of Al-Kura and Samma, about 15 miles N.E. of Dihala.

Genus OPPELIA, Waagen.

Oppelia? sp. (Pl. III. fig. 4.)

The flattened remains of a smooth minutely umbilicated shell about 39 mm. in diameter are probably referable to the genus *Oppelia*, but the fossil is too imperfect to be specifically determined.

Loc. Valleys between the villages of Al-Kura and Samma, about 15 miles N.E. of Dihala.

C. BELEMNOIDEA.

Genus BELEMNITES, Lister.

Belemnites cf. *hastatus*, H. D. de Blainville.

(Pl. II. figs. 1 a, b, c.)

1827. *Belemnites hastatus*, H. D. de Blainville, Mém. sur les Bélemn. p. 71, pl. i. fig. 4, pl. ii. fig. 4, pl. v. fig. 3.

* W. Waagen, *op. cit.* p. 4, 1875, p. 184, pl. liii.

† A. de Lapparent, 'Traité de Géologie,' 5th ed. 1906, vol. ii. pp. 1243 & 1255.

1842. *Belemnites hastatus* (pars), Blainville; A. D. d'Orbigny, Pal. Franç., Terr. jurass. vol. i. p. 121, pl. xviii.
 1848. *Belemnites semihastatus rotundus*, F. A. Quenstedt, Cephalopoden, p. 440, pl. xxix. fig. 8.
 1857. *Belemnites hastatus*, Blainville; A. Oppel, Juraformation, p. 546.
 1870. *Belemnites hastatus*, Blainville; J. Phillips, Brit. Belemnitidæ (Mon. Pal. Soc.), pt. 5, p. 111, pl. xxviii. figs. 67-70.
 1873. *Belemnites* cf. *hastatus*, Blainville; W. Waagen, Jurassic Fauna of Kutch, vol. i. Cephalopoda, pt. 1, p. 11.
 1876. *Belemnites hastatus*, Blainville; E. Favre, Description des Fossiles du terrain oxfordien des Alpes Fribourgeoises (Mém. Soc. Pal. Suisse, vol. iii.), p. 17, pl. i. figs. 1 a, b, c, 2, 3.

This genus is represented by a single specimen, apparently a portion of the posterior part of the guard. The fragment is feebly depressed and slightly hastate; it is truncated at each end, and at the anterior end there is no indication of the alveolus. The specimen is 64 mm. long; the ventro-dorsal and transverse diameters of the anterior end are 11 mm. and 12.75 mm. respectively, the corresponding diameters of the posterior end being 11 mm. and 12 mm. respectively. The dorsal and ventral surfaces are nearly parallel throughout the greater part of the length of the specimen, and it is only at a short distance from the posterior end of the fossil that they show any tendency to converge. In either a dorsal or ventral aspect the specimen is feebly hastate, and has its greatest width (15 mm.) at about 22 mm. from the posterior end. A ventral groove extends over the whole length of the specimen, being sharply defined at the anterior end and becoming wider and shallower towards the posterior extremity; the dorso-lateral area is slightly flattened and exhibits somewhat obscurely two dorso-lateral lines. The fossil seems to have formed part of a rather elongated guard, since it exhibits no trace of the alveolus at its anterior end.

The fossil appears to belong to the *Hastati*-group (= *Hibolithes*, Montfort*), and to be nearly allied to *Belemnites hastatus* †, but the guard is less fusiform and the ventral groove reached nearer the apex than in most examples of that species. But the extent of the ventral groove varies in examples which have been referred to this species. Thus Favre ‡ has referred to this species an example from the Oxfordian of the Alps of Fribourg in which the ventral groove

* D. de Montfort, Conchyl. Syst. vol. i. 1808, p. 386. Zittel includes this section in *Belemnopsis*, Bayle, which he regards as a subgenus of *Belemnites* (Grundzüge d. Palæont. 1895, p. 441; 2^{te} Aufl. 1903, p. 475).

† D. de Montfort, *loc. cit.* See also H. D. de Blainville, Mém. sur les Bélemn. 1827, p. 71, pl. i. fig. 4, pl. ii. fig. 4, pl. v. fig. 3.

‡ E. Favre, Description des fossiles du terrain oxfordien des Alpes Fribourgeoises (Mém. Soc. Pal. Suisse, vol. iii. 1876), pl. i. figs. 1 a, b, c.

extends to within a short distance of the posterior end of the guard; the Arabian specimen agrees very well with the median portion of such a form, but its ventral groove is relatively narrower. *Belemnites hastatus* is widely distributed and attains its maximum development in the zone of *Peltoceras biarmatum* (Lower Oxfordian). In England the species occurs throughout the Oxford Clay, and has also been recorded from the Calcareous Grit*. Besides occurring in Europe, fragments comparable with this species have been recorded from Cutch † from the portions of the Charee group ranging from the zone of *Reineckia anceps* through the zone of *Peltoceras athleta* up into the zone of *Aspidoceras perarmatum*, i. e. from the Lower Oxfordian up into the Corallian. The species has also been recorded from the Jurassic rocks of Hermon ‡.

The specimen bears considerable resemblance to *Belemnites persicus*, Weithofer §, from the Upper Jurassic (*tenuilobatus*-beds) of North-west Persia, but the transverse section of that species is more nearly circular.

The hastate and depressed character of the fossil seems to ally it also to Etallon's *Belemnites astartinus* ||. The extent of the ventral groove, however, differs very much in the figured examples which have been referred to this species. Thus in Etallon's type specimen from the Astartian of the Bernese Jura the groove extends over about two-thirds of the length of the guard; in an example figured by de Loriol ¶ from the beds of the zone of *Ammonites tenuilobatus* of Baden (Argovia) it extends over about one-half the length of the guard; in an example figured by the same author ** from the same horizon at Oberbuchsitten (Soleure) the groove is almost entirely confined to the anterior third of the guard,

* J. Phillips, *op. cit.* pt. 5, 1870, p. 112.

† W. Waagen, *Jurassic Fauna of Kutch (Pal. Indica)*, vol. i. The Cephalopoda, Introduction.

‡ Fritz Noetling, 'Der Jura am Hermon,' 1887, p. 33, pl. v. fig. 10.

§ K. A. Weithofer, *Sitzungsber. d. k. Akad. d. Wissensch., Wien, math.-naturw. Cl., Bd. xxviii. Heft 8-10, 1890, p. 757, pl. i. fig. 4.*

|| A. Etallon, *Lethæa Bruntrutana &c. pt. i. (Neue Denkschriften der allgemeinen Schweizerischen Gesellschaft für die gesammten Naturwissenschaften, Bd. xviii.)*, 1861, p. 74, pl. i. fig. 1.

¶ P. de Loriol, *Monographie paléontologique des couches de la zone à Ammonites tenuilobatus (Badener Schichten) de Baden (Argovie)*, pt. i. 1876 (*Mém. Soc. Pal. Suisse*, vol. iii.), p. 12, pl. i. figs. 14 & 15.

** P. de Loriol, *Monographie paléontologique des couches de la zone à Ammonites tenuilobatus (Badener Schichten) d'Oberbuchsitten et de Wangen (Soleure)*, pt. i. 1881 (*Mém. Soc. Pal. Suisse*, vol. vii.), p. 7, pl. i. fig. 5.

whilst in a specimen figured also by de Loriol* from the Upper Rauracian of the Bernese Jura the groove extends over about one-half the length of the guard. Further, there are differences in the amount of tapering of the anterior part of the guard, none of the examples mentioned above tapering so rapidly as Etallon's type-specimen. *Belemnites astartinus* does not appear to have usually attained such a large size as the Arabian fossil, the only figured example of that species at all comparable with the present specimen being that figured by de Loriol from the zone of *Ammonites tenuilobatus* at Oberbuchsitten (Soleure), but that tapers anteriorly more rapidly and has a considerably shorter groove.

It is neither so fusiform, so depressed, nor so widely grooved as the example figured by Quenstedt ('Die Cephalopoden,' 1849, pl. xxix. figs. 14 a-c) as *Belemnites hastatus depressus* (= *Belemnites calloviensis*, Oppel †). Compared with the form figured as *Belemnites subhastatus* by Waagen from the Jurassic rocks of Cutch, in which species Waagen includes the Cutch specimen figured by J. de C. Sowerby ‡ as *Belemnites canaliculatus*?, and afterwards renamed by d'Orbigny § *Belemnites grantanus*, the Arabian specimen appears to be part of a more elongated guard and to have possessed a much narrower ventral groove. Waagen || records *Belemnites subhastatus* as being not very common in the Cutch Jura, where it is apparently restricted to the beds with *Macrocephalites macrocephalus*.

The Arabian specimen is more depressed, more hastate, and provided with a narrower ventral groove than Waagen's *Belemnites kuntkotensis* ¶, which, according to that author, ranges in Cutch through the Katrol and Oomia groups, or, in other words, from the Upper Oxford to about Lower Tithonian beds; whilst it appears to have been more elongated and more depressed than that author's *Belemnites katrolensis* **, a species which in Cutch is characteristic of the

* P. de Loriol, Étude sur les mollusques du rauracien supérieur du Jura Bernois, Suppl. 1, 1895 (Mém. Soc. Pal. Suisse, vol. xxii.), p. 5, pl. i. fig. 1.

† A. Oppel, 'Die Juraformation,' 1856-8, p. 546 (1857). See also W. Waagen, Jurassic Fauna of Kutch (Pal. Indica), vol. i. The Cephalopoda, pt. 1, 1873, p. 14, pl. ii. figs. 4 a-d.

‡ J. de C. Sowerby, Trans. Geol. Soc. [2] vol. v. pt. 2, 1840, pl. xxiii. fig. 2 & expl.

§ A. d'Orbigny, Prod. de Paléont. 1850, vol. i. p. 326.

|| W. Waagen, Jurassic Fauna of Kutch (Pal. Indica), vol. i. The Cephalopoda, pt. 1, 1873, p. 15.

¶ W. Waagen, *ibid.* pt. 1, 1873, p. 3, pl. i. figs. 3 a-f.

** W. Waagen, *ibid.* pt. 1, 1873, p. 7, pl. ii. figs. 7, 8, 9.

Katrol group, although according to Waagen it seems to pass up into the Oomia group.

Compared with *Belemnites tangensis*, which Futterer * described from Tanga, in German East Africa, from rocks of Oxfordian age, the Arabian specimen appears to have belonged to a stouter and relatively more elongated guard, with a narrower ventral groove than that species, and similar differences are recognizable on comparison with the Belemnite fragments described by the present writer † from Bihin in Somaliland.

Loc. The specimen is labelled "Nobat," indicating, as stated by Major Hazelgrove in his letter accompanying the collection, that it was found about 7 miles from that place, at the end of a long valley which runs due north from Nobat Dakim. It is to be observed, however, that its mode of preservation is unlike that of the rest of the fossils similarly labelled, and that some fragments of matrix adhering to the specimen are identical with the matrix of the fossils from the N.E. of Dihala, and differ entirely from the matrix of the other Nobat specimens.

CONCLUSIONS.

From the foregoing descriptions it will be seen that these Arabian Jurassic Cephalopoda are allied, on the one hand, to such forms as occur in the Katrol Group of Cutch, the Upper Jurassic rocks of Niti and Spiti in the Himalaya, and the Upper Jurassic rocks of Somaliland; and, on the other hand, to forms occurring in the zone of *Oppelia tenuilobata* in Central Europe.

The Katrol Group in Cutch consists of two parts. According to Waagen ‡ the lower portion—the Kuntkote Sandstone—is the equivalent of the Upper Oxfordian beds of Central Europe, and probably represents the zones of *Pelto-ceras bimammatum* above and of *Pelto-ceras transversarium* below. The upper part—the Katrol sandstone and shales—comprises a complex group of strata several hundred feet in thickness, and may therefore, as Waagen pointed out, represent more than one palæontological horizon. The Katrol sandstone is well marked off both from the beds above as well as from the beds below, for, according to Waagen, only one

* K. Futterer, Zeitschr. Deutsch. geol. Gesell. Bd. xlv. (1894) p. 30, pl. v. figs. 2, 2 a-c, 3, 3 a-c.

† G. C. Crick, Geol. Mag. [4] vol. iii. (1896) pp. 296-8.

‡ W. Waagen, 'Jurassic Fauna of Kutch,' vol. i. The Cephalopoda, Introduction and pp. 230-232.

species of Cephalopoda (*Belemnites kunkotensis*) reappears in the bed from the Kunkote Sandstone below, and not a single species passes from this bed into the higher beds—the Oomia group. Waagen recognized only four European species in the Katrol Sandstone, all of which belong to the beds with *Aspidoceras acanthicum*. Hence he considered the Katrol Sandstone to be of Kimeridgian age and to be the equivalent of the zones of "*Perisphinctes*" *mutabilis* and *Oppelia tenuilobata*, a view generally adopted by subsequent writers*.

De Lapparent † refers the lower part of the Katrol Group to the Sequanian and the upper part to the Kimeridgian.

The fossiliferous deposits in the neighbourhood of the villages of Al-Kura and Samma, to the north-east of Dihala, are certainly of Upper Jurassic age, and are most probably homotaxial with the upper part of the Katrol Group in Cutch and with the zone of *Oppelia tenuilobata*, or the beds with *Aspidoceras acanthicum*, in Europe.

In his article on the "Jurassique" in the 'Grande Encyclopédie' (vol. xxi. 1895, pp. 322–331) Prof. Dr. E. Haug gives (p. 330) a map—after Neumayr and the more recent works of Nikitin, Rothpletz, and Hyatt—showing the distribution of sea and land during Upper Jurassic times. A Central Mediterranean sea is represented extending from the northern part of India on the east, over the western part of Asia, and almost the whole of Europe, as far as Central America on the west. From this sea a gulf—termed the Ethiopian gulf—is indicated, extending from the neighbourhood of Cutch and the southern part of Baluchistan in a south-westerly direction, terminating at the south between Madagascar and Africa. This excludes the whole of Arabia, but includes on the west Somaliland, a portion of Abyssinia, and the eastern coast of Africa as far south as the south of Madagascar, and on the east the north-western part of Madagascar.

The present discovery by Major Hazelgrove shows that the northern part of this gulf should include also the south-west part of Arabia.

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At present our knowledge of the sedimentary formations of

* See H. B. Medlicott and W. T. Blanford, *Manual Geol. India*, 2nd ed. (by R. D. Oldham), 1893, pp. 217 *et seq.*; J. W. Gregory, 'Jurassic Fauna of Cutch,' vol. ii. pt. 2, *The Corals*, 1900, p. 2.

† A. de Lapparent, 'Traité de Géologie,' 5^e éd. 1906 vol. ii. pp. 1243 & 1255.

Arabia appears to be limited to the rocks of Arabia Petræa in the north, mostly the Sinai neighbourhood, where Carboniferous, Cretaceous, and Tertiary beds have been distinguished by their fossils, due to the researches of J. W. Salter, Ralph Tate, Rothpletz, Duncan, Fourtan, &c. Cretaceous fossils are also known from Ras Fartak and Ras Sharwen on the south coast, which were first referred to by Dr. H. J. Carter and subsequently recognized by Dr. P. M. Duncan as of Cenomanian age; while the Tertiary rocks, mostly of Lutetian or Middle Eocene age, are to be found in the neighbourhood of Muskat (Ras Ghissa &c.) in the south-eastern corner of the country, which were originally recorded by the late Dr. H. J. Carter, and more recently referred to by Mr. G. C. Crick and myself.

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EXPLANATION OF THE PLATES.

PLATE I.

Parallelodon egertonianus, Stoliczka, sp. (Page 5.)

- Fig.* 1. External lateral view of a left valve.
Fig. 2. Interior of the left valve of another specimen, showing partial dental characters.
Fig. 3. Magnified view of external surface-structure.
Fig. 4. Dorsal aspect of a smaller specimen with both valves.

Nucula cuneiformis, J. de C. Sowerby. (P. 7.)

- Fig.* 5. Dorsal view of specimen with both valves.
Fig. 6. Internal section of another specimen with both valves, showing dentition.
Fig. 7. Posterior end of another form with both valves, showing the wide lunule, $\times 2$.

Trochus arabiensis, sp. n. (P. 8.)

- Figs.* 8, 9. Views of separate specimens, *fig.* 9 being more inflated at the base.

Nerinæa cf. desvoidyi, Orbigny. (P. 9.)

- Fig.* 10. Natural cast, showing the median excavation of the whorls.

PLATE II.

- Fig.* 1. *Belemnites cf. hastatus*, Blainville. 1 *a*, ventral aspect, exhibiting the narrow ventral groove, widening out and becoming shallower at the posterior end; 1 *b*, view of anterior end of the same specimen; 1 *c*, view of posterior end of the same. The specimen is labelled "Nobat." (P. 19.)
- Fig.* 2. *Nautilus cf. hexagonus*, J. de C. Sowerby. Lateral aspect, showing subangular margin of periphery and the growth-lines of the test. Near the villages of Al-Kura and Samma, 15 miles N.E. of Dihala. (P. 11.)
- Fig.* 3. *Perisphinctes cf. subdolutus*, F. Fontannes. Lateral aspect of specimen, the inner whorls of which are obscured by matrix. Near the villages of Al-Kura and Samma, 15 miles N.E. of Dihala. (P. 17.)

PLATE III.

- Fig. 1. *Perisphinctes* cf. *torquatus*, J. de C. Sowerby, sp. 1 *a*, lateral aspect; 1 *b*, a portion of the periphery at the point marked with a cross in 1 *a*. Near the villages of Al-Kura and Samma, 15 miles N.E. of Dihala. (P. 14.)
- Fig. 2. *Perisphinctes* cf. *abadiensis*, P. Choffat. Lateral aspect of exerted portion of fossil, the rest being obscured by matrix. Near the villages of Al-Kura and Samma, 15 miles N.E. of Dihala. (P. 18.)
- Fig. 3. *Perisphinctes* cf. *pottingeri*, J. de C. Sowerby, sp. 3 *a*, lateral aspect of fragment; 3 *b*, peripheral view of the same. Near the villages of Al-Kura and Samma, 15 miles N.E. of Dihala. (P. 18.)
- Fig. 4. *Oppelia*? sp. A smooth internal cast probably referable to this genus. Near the villages of Al-Kura and Samma, 15 miles N.E. of Dihala. (P. 19.)

Note.—Except where notified, the figures on these Plates are drawn of the natural size.

II.—*Descriptions of Two new Cyprinodontid Fishes from West Africa.* By G. A. BOULENGER, F.R.S.

Fundulus arnoldi.

Depth of body $4\frac{1}{2}$ to $5\frac{1}{2}$ times in total length, length of head 3 to $3\frac{1}{3}$ times. Snout a little shorter than eye, the diameter of which is $3\frac{1}{2}$ times in length of head; lower jaw projecting beyond upper; interorbital width $\frac{2}{3}$ length of head. Dorsal 15–16, originating slightly in advance of anal, above tenth or eleventh scale of lateral line, and at equal distance from eye and from root of caudal; longest (posterior) ray quite as long as head in males, shorter in females. Anal 15–17, similar to dorsal. Pectoral about $\frac{2}{3}$ length of head. Caudal rounded in females, with upper and lower rays produced in males. Caudal peduncle twice as long as deep. Scales 25–27 in longitudinal series, 20–22 round body; an interrupted series of lateral line pits. Pale olive, spotted or dotted with crimson on the head, body, and vertical fins. According to Mr. Arnold's coloured sketches, the male has a blackish band along the upper part of the dorsal and anal fins.

Total length 45 mm.

Several specimens were presented to the British Museum by Mr. J. P. Arnold, of Hamburg; this fish, which he kept in his aquarium, formed part of an interesting series brought